Article

Convergent Quantitative Solutions Indicating the Human Hippocampus as a Singularity and Access to Cosmological Consciousness

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ABSTRACT

A quantitative neuroquantal approach to the unique physical characteristics of the human hippocampus and the parahippocampal gyrus is developed. The mass of the DNA within the defined range of neurons within the hippocampus is congruent with Planck's mass and the radius of this singularity is Planck's length. The Casimir energy for the synapse which is equivalent to the radius of neutral hydrogen, the convergence of power density at the level of the neuronal membrane and the universal boundary, and the identity between the quantum of energy lost by a bit of information and a completed sequence in the Papez pathway suggest the unique features of the human hippocampus may reveal the intrinsic nature of how we perceive the universe.

Key Words: hippocampus, information, universal boundary, Planck's values, hydrogen, singularity

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Introduction

The explanations for the absolute nature of consciousness have been distributed historically along a continuum that ranges from extreme materialism to idealism. Consequently, the fundamental operations of most philosophies range from the assumption consciousness is determined by the physical laws of matter and energy to energy and matter as being constructs or "creations" of consciousness. Within the quantum domain that includes Casimir phenomena whereby virtual particles can be transformed under optimal conditions to particles with mass, there are other perspectives (Casimir, 1948; Bordag *et al.,* 2001). The perspective developed in this paper is that consciousness is a boundary condition between a singularity (black hole) and space within the brain. A locus that might display the required properties within the cerebral volume is the hippocampus. This structure is the gateway to the type (declarative) of memory that is correlative with conscious experience (Kandel *et al.,* 2000; Anderson, 2007) and defines the unique characteristics of the individual.

Although the concept of space is usually focused outward to the boundaries of the universe, the actual orders of magnitude are less than that encountered within inner space. Stated alternatively, the largest spatial unit, the universe, is estimated to be about 10^{26} m in radius while the smallest calculated space, Planck's length, is ~10^{-35} m. Consequently there are more degrees of freedom (with respect to powers of ten) within a volume of space, such as the human cerebrum, converging into Planck's length than the same volume of space diverging to the universal set.

This implication is more obvious when the equivalence is drawn between the numbers of units of matter that comprise the solar system is related to the comparable numbers of units of Planck voxels (3-dimensional

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units). The solar system has a mass of ~10^{31} kg that is composed of approximately 10^{58} protons (10^{-45} m^3) for a total volume of about 10^{33} m^3. If the basic unit was a Planck's volume (10^{-105} m^3) rather than a proton the proportional volume for the entire solar system would be 10^{60} smaller and would occupy about 10^{-27} m^3 or a length within the range between the width of the hydrogen atom to the width of a channel (1 nm) within a neuronal cell membrane.

One traditional approach to pursuing the validity of concepts that are difficult, but not impossible, to verify experimentally is to purse the consistency of the quantitative solutions that relate central components to the theory. We assume here that the central mass unit associated with the physical bases of the phenomena that define our reality is the simplest complex of a proton and an electron, the hydrogen atom. Metrics related to these phenomena should be related in a meaningful and systematic manner to the key parameters that occur at the level of the synapse and the neuronal plasma membrane ion channel as well as the values that define the boundaries of our current concepts of the smallest (~10^{-35} m) and largest (~10^{26} m) spaces.

Casimir Pressures and Forces

The human brain is the matter within a volume that may contain properties that facilitate the transformation of virtual particles existing at the level Planck's length to actual matter. As indicated by Bordag et al. (2001) an infinite vacuum energy of quantized electromagnetic field in free Minkowski space can be shown to allow a finite force between two parallel neutral plates. This Casimir force involves the existence of zero-point oscillations which are associated with the point values of a quantized field. Boundaries composed of matter polarize the vacuum of a quantized field. The energy over distance is a consequence of the result of vacuum polarization by an external field.

One of the possibilities of vacuum quantum effects is the creation of particles from the vacuum by external fields. Energy is transferred from the external field to virtual particles or vacuum oscillations, much like Eddington's formulation (Klimchitskaya *et al.*, 2009; Persinger, 2012), to produce real particles. However this effect of transformation requires the boundary condition to be a function of time (time-varying) rather than static conditions.

In other words, a transformation of the state of particles occurs when there is a changing electromagnetic field that contributes to or defines a boundary condition. The degrees of freedom for this potential are markedly enhanced by the unique property of attraction or repulsion depending upon the geometry and topology of the quantized manifold or shape. The recursive, changing electromagnetic fields, much like a classical tensor, that occurs within synaptic space and across the cerebral cortical manifold during the ~20 ms "recreation" of consciousness, could be preconditions to allow this virtual-to-matter transitions.

The synapse, the primary interface between two neurons, is effectively two plates where the width is much larger than the separation between the apposing boundaries of a Casimir condition. These "plates" are in the order of 1,000 to 2,000 nm wide and are separated by 10 nm. Assuming a width of 2 μm (an area of $4 \cdot 10^{-12}$ m^2), the Casimir force during discrete intervals of neutrality between the "plates" or boundaries would be about 0.5 microNewtons. When applied across the 10 nm synaptic cleft, the energy would be $0.5 \cdot 10^{-14} J$.

The frequency equivalence of that energy, when divided by Planck's constant ($6.624 \cdot 10^{-34}$ J·s), is $.078 \cdot 10^{20}$ Hz. The equivalent wavelength, assuming c is the velocity of light in a vacuum is $3.8 \cdot 10^{-11}$ m or 38 pm. This length is within error measurement of the width of the neutral hydrogen atom. Such convergence would be expected between Casimir transformations from virtual to real particles and the component that composes 90% of the matter in the universe. Hydrogen is the essential unit by which aggregates of heavier elements are formed.

The Human Hippocampus as a Unique Locus

Within the human brain the hippocampus has been considered the gateway to personal memory and to the representation of experience as electromagnetic phenomena within intracerebral and extracererbal space. Most models indicate that consciousness is not likely without some memory component

because the former is based upon re-entrant processes and access to some reference point during any given input. The bidirectional interaction between the cerebral cortices and the hippocampus is reflected as well by the ~40 Hz ripples (Buzsaki, 2002; Holz *et al.,* 2010), the presumed major correlate of consciousness, that is superimposed upon the fundamental theta frequency of aggregates of hippocampal neurons.

The structure of the human hippocampus is similar to two interlocking C-shaped structures that are congruous geometrically with the smaller spherical condenser wrapped and partially interfaced by a larger spherical condenser (Bear, 1996; Gloor, 1997). The particular geometry is similar in shape to a toroid with a gap that allows a discrete, because of the dimensions of the gap, leakage of magnetic flux. It is affected by the polarization or phase vector of the accompanying electromagnetic field that can be matched within the same order of magnitude as the scalar potential for the representation of the geomagnetic field within this space (Corson and Lorrain, 1962; Winch *et al.,* 2005).

In addition to generating frequencies within the range that overlap with the essential time constants of the plasma membranes (Persinger, 2008) that compose these neurons and the base fundamental frequency associated with earth-ionospheric cavity (Persinger, 2008), the hippocampal formation and the adjacent parahippocampal gyrus are the foci for all efferent and afferent information from the cerebral cortices. This is a unique condition. Within the parahippocampal gyrus sensory modality-specific line codes are transformed to the general, frequency and phase-modulated patterns that mediate cerebral information. Experimental support for the generalized, frequency-based format of information transfer within brain space regardless of modality was shown decades ago by E. Roy John (1972).

The densely packed layers of granule cells and pyramidal cells exhibit configurations that are unique within the brain. The pyramidal cells occupy functional widths of approximately 75 μm. This value is the intersection between slopes for the expansion of space and the convergence of the associated electromagnetic length (Persinger & Koren, 2007). This particular width is also within the range that might allow access to representations within real Hilbert space (Persinger, 2008).

The synapses within the human hippocampus are *en passant* types that appear like beads along a string with axon intervals of between 1 μm and 2 μm. This value was considered significant by Bohr because it was the constant for the relationship between motion and matter. Bohr's frequency is derived from $1.32\ \omega_o\sqrt{m \cdot M^{-1}}$ where m is the mass of the electron, M is the mass of a proton, and ω_o is the fine structure velocity of the electron of $\sim 6.2 \cdot 10^{15}$ Hz. If it is divided into the expected range of the velocity of light within brain tissue the radius is between 1 μm and 2 μm.

From our perspective it is not spurious that the discrepancy between the Compton wavelength of an electron ($2.426 \cdot 10^{-12}$ m) and the classic radius of $2.817 \cdot 10^{-15}$ m would require a v^2c^{-2} ratio of 0.99999865 for the Lorenz contraction to match the discrepancy of ~861 between the two values. The difference in energy ($1/2\ mv^2$) between the two velocities assuming the classical mass of an electron would result in an incremental difference of $1.1 \cdot 10^{-19}$ J. When divided by Planck's constant to obtain frequency the equivalent wavelength would be ~1.9 μm.

Although the electromagnetic patterns may contain the information that affects the structure of matter, a molecular structure is required to maintain the physical conditions under which the electromagnetic patterns can exist for protracted periods within local space. The molecular pattern with one of the longest consistent temporal history is the DNA molecule.

Hippocampal DNA Mass as a Manifestation of Singularity

The mass of the DNA within each neuron is about 7 pg or 7×10^{-15} kg. It may not be coincidence that within the human hippocampus there are approximately 10^7 neurons (West & Gundersen, 1990; West *et al.,* 1994; West & Slomianka, 1998) such that the total DNA mass is $\sim 10^{-8}$ kg. This value is within the same order of magnitude as Planck's mass (2.1×10^{-8} kg). If we assume the values of space, time, and mass Planck derived from essential constants that define our

construct of the universe involve meaningful and relevant values, then their appropriate inclusion should reveal the manner in which human hippocampal parameters are associated with universal characteristics.

The singularity was the model for our analyses because this condition contains the entire information for all elements in a set within a discrete boundary condition. The classical definition of a singularity, according to Schwartzchild, is $r=2GM/c^2$. When the mass of DNA within the nuclei of the field of all cells within the human hippocampus is solved, the radius is 10^{-35} m. Stated alternatively the radius of the singularity defined by the aggregate mass of DNA within the human hippocampus is within the same order of magnitude as Planck's length, the smallest unit of space obtained from combining the basic units of physics: h=Planck's constant, c=the velocity of light and G=the universal gravitational constant.

The information within this hippocampal singularity could be described as the entropy of the black hole according to relation: $s=kA/4L_p^2$ where k=Boltzmann's constant, A= the cross sectional area of the black hole (10^{-70} m^2) and $L_{p=}$ Planck's length. The entropy solution, s, for the DNA mass within the hippocampal volume of the human brain would be 9×10^{-24} J/K. Assuming the biological temperature of 310°K, the energy would be 2.8×10^{-21} J.

This value is not only specific but precisely the quantity of energy associated with the Landauer Limit which is the threshold at which one bit of information is lost during the convergence of operations or when a bit of information is dissipated into entropy. Landauer's classic equation is s=ln2 kT. This value at biological temperatures (37°C, 310°K) is 2.97×10^{-21} J. Within the context of the hippocampus information could be lost once the reverberations within the cerebral cortico-hippocampal and classical Papez pathways cease or converge.

The operations could also converge through the bidirectional activity between the hippocampal region and the cerebral cortices during the consolidation process. Many researchers have suggested that this congruence and the time (that is 20 ms) required for completion of the serial connections is the primary correlate of consciousness. In fact the average transit time within the hippocampal-cortical network is about 20 msec which has been considered the time frame of the second derivative or rate of rate of change as the transcerebral cortical fields, moving in a rostral to caudal to direction at about 4.5 m/s (Nunez, 1995; Persinger, 2012).

The Universal Boundary and Cerebral Information

The equivalent frequency for the energy loss of one bit of information into entropy during erasure or convergence of pathways is $0.44 \cdot 10^{13}$ Hz. Assuming the velocity of light in a vacuum the wavelength is 68 um. However, if one accommodates for the velocity of light in water and brain tissue, for the 500 to 550 nm wavelengths (about $2.2 \cdot 10^8$ m$\cdot$s^{-1}), the wavelength is closer to about 50 μm.

This is an important value when the Casimir equation is applied to the entire universal surface (Koren & Persinger, 2010). Bordag et al (2001) has defined the Casimir effect as a quantum manifestation involving the "infinite" vacuum energy of the quantized electromagnetic field in free Minkowski space. If one assumes a single integrated surface then the separation between that surface and another superimposed bound surface can be determined (Koren & Persinger, 2010) by the transformation of the Casimir equation to: $a=[(\pi^2\hbar c)\cdot S)(240F)^{-1}]^{1/4}$, where F is the total force of the universe, S is its surface area, and ħ is the modified Planck's constant.

To obtain "a" we assumed that the intrinsic pressure of the universe was about $15 \cdot 10^{-11}$ Pa. The validity for this assumption was derived from the estimated mass of the universe (10^{52} kg), a value in the same order of magnitude as empirical estimates, by assuming an average universal mass of 1 proton ($1.6 \cdot 10^{-27}$ kg) per m^3 (Wyatt, 1964; Persinger, 2009). The product of this value and the square of the velocity of light is $15 \cdot 10^{-11}$ Pa. According to the equation, the separation would be ~54 μm.

Consequently the wavelength of the energy associated with the loss of one bit of information into entropy is convergent with the estimated separation of the two infinite but bounded concentric surfaces separated by ~50 μm that define the known universe. We propose that this congruence suggests that

energy dissipated or retrieved with one bit of information might be represented within this space between the concentric boundaries that define the horizon for the current four-dimensional space of the universe.

There should be congruence between the universal pressure of $1.5 \cdot 10^{-10}$ Pa (kg m^{-1} s^{-2}) and hippocampal parameters within cerebral volumes. The latter is about 10^{-3} m^3 which results in an energy within the cerebral volume from the universal pressure of $1.5 \cdot 10^{-13}$ J. Assuming the typical $2 \cdot 10^{-20}$ J per action potential that energy be equivalent to the activity of about 10^7 neurons or, with an average 7 Hz discharge frequency, between 10^6 and 10^7 neurons per second. This is the range of values of neurons (particularly within the CA1 region) specifically clustered within the hippocampus.

This congruence could suggest that energetic functioning of the hippocampus reflects the intrinsic pressure of the entire universe. Such conditions would be required if the human hippocampus contained representations of the whole. Its activity would not be maintained within this "narrow band" but display perturbation, like an attractor, around it. Consequently access would occur only during brief increments when the neuronal activity moves through the quantitative boundary.

Holographic Representation

The concept that the basic unit represented upon the whole and the whole is represented upon the basic unit is the assumption of generic holographic models. There is quantitative evidence this condition could exist. The range of expansion of Hubble's constant is between 50 and 100 $km \cdot s^{-1}$ per Mparsec or between $1.6 \cdot 10^{-18}$ s^{-1} and $3.2 \cdot 10^{-18}$ s^{-1} respectively. For the intermediate value (75 $km \cdot s^{-1}$) the value is $2.4 \cdot 10^{-18}$ s^{-1}. The velocity of expansion for any space and the matter occupying it would be this value multiplied by the width (length) of the space.

The time to expand one Planck's length can be inferred by dividing the velocity of expansion by Planck's length. For the largest value, the approximate width of the universe ($\sim 10^{26}$ m), the time required would be approaching Planck's time ($\sim 10^{-44}$ s). On the other hand the time required for the smallest length, Plank's length ($\sim 10^{-35}$ m), would involve the approximate age ($\sim 10^{17}$ s) of the universe. Stated alternatively, the universe would require one Planck's time to expand one Planck unit in space while one Planck unit would require the time the universe has existed to expand this minute distance. These solutions establish the condition by which the whole and the element are related (Koren & Persinger, 2010).

This Casimir solution of 54 μm for the separation between the two universal concentric boundaries, assuming the properties of a black body, is equivalent to a temperature from Wien's law of 53 K. From Stefan's law, the power density would be the product of T^4 and the constant $5.67 \cdot 10^{-8}$ $W \cdot m^{-2}$ or 0.45 $W \cdot m^{-2}$. Assuming the energy density is distributed more or less equally over the universal boundary the attenuation would be r^{-1}. If the solar system is towards the center of the universe, as inferred from red- and blue-shifts, then the density would be about 0.5 Jy (1 Jansky=10^{-26} $W \cdot m^{-2} \cdot Hz^{-1}$).

This magnitude may appear very small. However the photon energy from the human brain while imagining light has been shown several times to be $\sim 10^{-10}$ $W \cdot m^{-2}$ (Dotta & Persinger, 2011; Dotta *et al.,* 2012). The quantum of energy within the cross-section area (10^{-16} m^2) for the symmetrical width of a 10 nm plasma cell membrane of a neuron would result in a value of 10^{-26} W. If one assumes that the surface areas of all neuronal soma ($\sim \pi \cdot 10^{-10}$ m^2), of which there is about $3 \cdot 10^{10}$ within the cerebral cortices of one hemisphere, then the 10^{-26} W would be distributed over a wrapped surface of ~1 m^2. Because the soma surface area is less than 10% of the area of the entire cell, representing the membrane extension into dendrites and the axon, the functional surface for each cell is actually larger.

Thus very much like the calculations that show the energy within the cerebrum from the electromagnetic energy associated with a single action potential (10^{-20} J) summed over 10^7 neurons each discharging at 10 Hz results in an energy density of 10^{-9} $J \cdot m^3$ which is the average density of the universe (10^{69} J divided by its volume of 10^{78} m^3) the equivalence of photon-based energy density at the membrane level of the human brain reflects the energy density generated within the boundaries of the universe. Such similarities of magnitude would be expected to

be a necessary condition for the essential contents of consciousness to be represented within the universe as a "cosmological" consciousness and its essential contents to be reflected during specific times in awareness.

Hogan (2008) has developed theoretical and quantitative support for the holographic behaviour of space-time in order to accommodate the properties of the scaling of entropy over area rather than within volume and the non-locality of quantum correlations. Both conditions are holographic properties and contradict classical field theory. From his perspective the spectrum of holographic noise is universal and depends only upon Planck's length. The power spectral density is independent of frequency and is described in mean square dimensionless metric perturbations per frequency interval as: $\sqrt{(L_P/c)}$ which reflects the rms amplitude of the holographic noise in terms of equivalent metric shear. In this instance shear is equivalent to the hadronic shear current related to gravitational potentials within Minkowski space. That gravity and electromagnetic phenomena may converge within the frequency range juxtaposed with the lengths congruent with hippocampal interaction has been shown quantitatively (Persinger, 2008). Hogan's value for holographic noise was $2.3 \cdot 10^{-22}$ $(\sqrt{Hz})^{-1/2}$. When multiplied by the square of a particular frequency, it becomes a dimensionless value.

If this holographic noise constant for a single 1 Hz band was applied to the rotational frequency of the hydrogen electron ($6.8 \cdot 10^{15}$ Hz) there would be a "noise" displacement per second of about $1.56 \cdot 10^{-6}$ proportions. When applied to the 1.42 GHz hydrogen band that is spread across the universe, this would be equivalent to about $2.2 \cdot 10^{3}$ Hz superimposed upon the 21 cm band. The duration of one cycle of the latter frequency is about 0.5 msec which is the central domain of the peak duration of the average action potential generated along axons. We suggest this confluence of values supports our argument that the holographic "noise" within intrinsic structure of multidimensional space is accessed during the brief action potential spikes. The information is not within the spikes themselves but within the temporal organization of their patterns.

An extension of the power spectral density for holographic noise might be accommodated as well by $\sqrt{(L_P/(c^2 \cdot m^{-1}))}$ where m is the approximate width of the universe. The resulting unit is a temporal unit (s). The solution (10^{-35} m/10^{-10} $s^2 \cdot m$) would be ~10^{-12} s. This duration is within the range of the duration of the most ubiquitous and ephemeral representation of H^+ in biological tissue within the hydronium ion. Experimental measurements indicate that the duration the additional H+ resides within the H_3O^+ molecule is between 0.3 and 2 ps. Water, the medium that supports the chemistry of living systems, would be an optimal conduit by which the holographic process could be mediated. H_2O is the only molecule where the structure remains the same although ultimately all of the H^+ units that compose a single molecule are not the same.

Consciousness as a Field

The representation of consciousness as a field or manifold has been expressed in various forms. In this model area $(m^2)=\Phi \cdot c^2$, where Φ is consciousness and c is the velocity of light. Φ is expressed as squared duration. Employing the average cross-sectional area of the human cerebrum to be 10^{-2} m^2 , then the basic time unit for consciousness is $(10^{-2}$ $m^2)/(9 \cdot 10^{-18}$ m^2 $s^{-2})$ or 0.3 nanos, the time required for one ion of the approximately 6 to 7 million ions moving through a ion channel of a membrane channel during the production of action potentials.

If consciousness is coupled to the intrinsic element of the universe, hydrogen, then the movement of a this element in some form should occur within this temporal increment. Both theoretical inference and empirical calculations indicate that a molecule of dihydrous oxide (water) precedes and follows the single ions as each moves through the channel between both sides of the plasma membrane. Considering the more recent revelation that there are more proton channels in the plasma membrane than all other channels and the measurement that interfacial water displays properties, including a potential difference in the order of 100 mV due to thin layers of protons, consciousness would be connected intimately to hydrogen within an aqueous state.

Conclusion

From an interdisciplinary and quantitative perspective that includes cosmological considerations, the basic quantum features of the units of matter, and the physical characteristics of the human hippocampus, there is evidence that the perceived nature of the universe may occupy a unique representation within the human hippocampus. We have assumed that microcosm reflects macrocosm, which is a central theme in human philosophies. If this approach is valid then a *neuroquantal* approach to the properties and potentials of the human hippocampus may be reveal the presently recondite properties of how we perceive the universe is structured as well as the principles that reflect its function.

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